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EFFECTIVENESS OF DIFFERENT METHODS OF CAR-PRECOOLING OF ORANGES IN FLORIDA, 1942

By

A. Lloyd Ryall, horticulturist, John R. Winston, senior horticulturist, and W. Robert Henry, minor scientific helper, Division of Fruit and Vegetable Crops and Diseases.

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Florida Citrus Commission

Effectiveness of Different Methods of Car-Precooling of Oranges in Florida 1942 1/

By A. Lloyd Ryall, horticulturist, John R. Winston, Senior horticulturist, and W. Robert Henry, minor scientific helper, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture.

The studies on precooling 2/ of oranges covered in this report are a continuation of those conducted during the season of 1940-41. The plan drawn up at the beginning of the season 1941-42 was to confine the work to fruit packed in standard boxes since but little if any data had been obtained on car precooling of Florida oranges in this container.

1/ This project is part of a broad study of Florida citrus handling and transportation investigations conducted by the U. S. Department of Agriculture in cooperation with the Florida Citrus Commission and Florida shippers. The tests reported herein were conducted at the Adams Packing Company and the Clark Fruit Company. Thanks is extended to the management and foreman of these agencies for their generous cooperation and assistance.

2/ "Precool" is the term commonly applied to rapid removal of heat from a perishable commodity through means of artificial refrigeration applied at loading point within a short time after the commodity is harvested. The object is to quickly reduce the temperature of the commodity to a degree at which normal physiological processes which bring on senescence are retarded and the invasion by parasitic organisms which produce decay is delayed. The desirable temperature varies with the commodity and the spoilage agents to be coped with. In the case of Florida oranges and grapefruit a rapid reduction to a temperature of 50° F soon after packing and a maintenance of this temperature during short periods of transit is highly desirable.

Later, at the request of the Florida Citrus Exchange, the program was broadened to include fruit packed in wire-bound crates.

Due to a series of unavoidable circumstances authority to initiate the investigation was not granted until late October. By that time the weather had become fairly cool and the need for precooling was lessened so that opportunities to make comparative tests were correspondingly reduced and only two tests were conducted during the fall. They were with color-added, wrapped oranges packed in standard nailed crates.

When the work was resumed in the spring an attempt was made to evaluate some of the precooling methods in use during the relatively brief period of April and May when high temperatures at loading time make some cooling desirable. These tests were with non-wrapped oranges packed in wire-bound crates.

Equipment used

Both bunker fans and truck-mounted refrigerating units were used in these tests.

The bunker fans were of the regular precooling type with cylindrical housing of sheet metal, the eight-blade fans being 17 inches in diameter. The fans were driven by a direct shaft from a $\frac{1}{4}$-h.p. motor at 1725 r.p.m. The portion of the bulkhead not covered by the fan was blocked off by a suitable baffle.

The mechanical unit in the test was the commonly used truck-mounted type with the compressor operated from the truck motor, and a built-in blower-type fan to circulate the air over expansion coils and through a canvas tunnel into the doorway of the car. The air was blown through the upper half of the doorway over the top of the load and then drawn back through the load and out the bottom half of the tunnel to the coils.

Fruit temperatures during precooling were obtained with electrical resistance bulbs inserted in fruit in the second layer of 10 boxes placed in different parts of the load. These boxes were located as follows: bottom bunker centerline, top bunker centerline, bottom quarterlength centerline, top quarterlength centerline, bottom quarterlength at car wall, top quarterlength at car wall, bottom doorway centerline, top doorway centerline, bottom doorway at car wall, and top doorway at car wall. Air temperatures during precooling were obtained at the points of coldest and warmest air, namely, in the blast from and the return to the refrigerating medium.

Temperature readings were made every one-half to one hour during precooling. In a few cases, when the car remained at the packing house after precooling, additional temperatures were taken to determine changes that occurred before the cars were moved by the pick-up engine to be iced or re-iced.

The period of precooling, the icing and salting method, etc., (Table 1) were generally those which the shipper had been using, since the interest among shippers centered largely on the amount of cooling that could be secured with the prevailing precooling practice. Such variations as are noted in icing and salting were used to demonstrate what might result from a change in the usual procedure.

Results

Tests with standard nailed crates (Oct., Nov.): The object of these tests was to obtain information on the rate of precooling with bunker fans, ice, and salt, of wrapped oranges packed in standard nailed crates and loaded "tight", that is, seven rows across instead of the more common practice of six across throughout the car. With this close packing, the air channels between the rows were reduced to the minimum.

Tests A and B were made October 31 and November 1. Outside temperatures on the two days were similar, ranging within 2 degrees, and commodity temperatures in the two cars during loading were within a few degrees, so that conditions were about parallel.

The loading temperature of fruit in car A ranged from 93 degrees to 95 degrees F. and in car B from 86 degrees to 96 degrees, averaging 94.5 degrees and 91.1 degrees, respectively. As shown in table 2 the maximum spread in commodity temperature was obtained at the end of the fifth hour of precooling when it was 15.2 degrees for car A and 21.2 degrees for car B. After six hours of precooling, the commodity temperature ranged from 75.4 degrees to 60.5 degrees in car A and from 75.1 degrees to 56.0 degrees in car B. This wide spread in temperatures, indicating lack of uniform chilling makes it obvious that six hours operation did not provide effective precooling.

The average of the ten commodity temperatures was 91.6 degrees in car A at start of precooling and 86.4 degrees in car B, a difference of 5.2 degrees. After six hours' precooling it dropped to 67.7 degrees and 67.0 degrees, respectively. The greatest reduction was in the top of the load.

In car A, with the warmer fruit, the average drop was 23.9 degrees, and in car B it was 19.4 degrees. There was a total reduction of 26.3 degrees after seven and a half hours in car A and 20.8 degrees after six and two-thirds hours in car B. In the top layers of car A the average commodity temperature dropped from 92.3 degrees at the beginning of precooling to 63.2 degrees at the end, and in the bottom layer from 90.8 to 67.3 degrees during precooling. In car B the commodity temperature in the top of the load dropped from 88.5 degrees at the beginning of precooling to 60.1 degrees at the end, and in the bottom of the load from 84.4 to 71.0 degrees during precooling.

As is always found in precooling, the rate of temperature reduction was greatest during the first hour, being 6.8 degrees in car A and 5.3 degrees in car B. As the precooling continued the rate of temperature reduction decreased to 3 degrees and 0.6 degrees, respectively, during the sixth hour.

From these tests it is obvious that a 400-crate load of oranges packed in standard nailed crates requires considerably more than six hours to effect satisfactory precooling; yet in actual commercial operations few cars are precooled more than six hours.

Car B was held several hours for the pick-up after the fans were stopped. It was possible therefore to determine commodity temperatures during the interval. In the bottom of the load the average of all temperatures fell rapidly, a total of 14.9 degrees during the six and one-half hour period between the removal of the bunker fans and the arrival of the pick-up train, while in the top of the load it rose 2.4 degrees. The rapid cooling in the bottom of the load after the fans were stopped was due to the resumption of natural circulation in the iced cars.

Tests with wire-bound crates (Apr., May): Bunker fans. Table 3 shows a comparison of results obtained in tests on two methods of salting the bunker ice with the precooling fans placed at the top bulkhead openings. Both cars were iced with 9600 pounds of chunk ice (75 to 100 lb. chunks). Car C had 300 pounds of salt added just prior to starting the fans and no more salt was added thereafter. Car D had 200 pounds of salt added at the start of precooling and three hours later the ice was barred down to fill up channels and "pockets" and an additional 200 pounds of salt was added.

As shown by the fruit temperatures, the latter method of salting was more effective. Average fruit temperatures were 4.2 degrees higher in car D than in car C at the start of precooling, and 2 degrees lower at the completion of precooling. Average fruit temperature reduction was 1.7 degrees per hour in car D and only 0.8 degrees per hour in car C. As would be expected, the air blast temperature in car D was lower than that in car C, especially after the second application of salt to car D.

Table 4 shows the results of a test made to determine the effect of size of ice chunks on the rate of precooling with bunker fans. Car E was iced with chunks ranging in size from 75 to 100 pounds and car F with ice that was chopped much smaller, the chunks being approximately 5 to 15 pounds. The same amount of salt (300 lbs.) was added to each car and in each case all of the salt was added just before starting the fans. As the fruit temperatures show, no great difference in precooling was obtained in the two cars. Car F, iced with small chunks, averaged slightly better for the five-hour period but the difference is hardly significant. The precooling period for these cars, however, was only five hours and from the general trend of the temperature drop it appears that the difference in favor of car F would have been greater with longer operation. It is interesting to note that the air blast was 10 degrees to 12 degrees lower in car F than in car E during most of the precooling period. The fact that this difference in blast temperature did not result in a greater difference in fruit temperature probably is due to a reduction in the volume of air that could be moved through the mass of smaller chunk ice due to smaller air channels and increased resistance.

The results of a second test on the effect of size of ice chunks are reported in table 5. In this test 400 pounds of salt were added to each car instead of 300 pounds as in the previous test and the fans were operated for nearly seven hours as compared with only five hours in the first test (table 4). In this test the temperatures show that materially faster cooling was accomplished with the smaller size ice (car H) than with the chunk ice (car G). Fruit in the top layer of car H averaged about 77 degrees at the beginning of precooling and about 51 degrees when the fans were stopped. The top layer fruit of car G averaged about 73 degrees at the start and 55.5 degrees at the end of precooling. Differences in the bottom layer averages were smaller but again in favor of car H.

Average fruit temperatures for the car were reduced from 75.4 degrees to 58.1 degrees in car H and from 69.7 to 59.1 degrees in car G. The hourly reduction in fruit temperature was 2.5 degrees in car H and only 1.5 degrees in car G. After the first hour of operation, air blast temperature was significantly lower in the car with the smaller size ice.

Mechanical Units. Table 6 shows the results obtained in cooling a load of 420 Bruce boxes with a truck-mounted mechanical refrigerating unit. The average fruit temperature at the start of precooling was 82 degrees F. The commodity in the bottom layers cooled to an average of about 62 degrees in nine hours, while that in the top layers cooled to an average of about 55 degrees. The temperature of the air from the mechanical unit gradually decreased from 50.5 degrees one-half hour after starting to 34.5 degrees by the end of precooling.

The common practice in precooling with a mechanical unit is to load and precool the car with the bunkers dry and ice the car sometime after precooling has been completed. Under this practice the cars often stand for a number of hours after precooling before being moved to the dock for icing.

Table 6 shows the temperature change which occurred during the 14 hours the car remained without ice after being cooled. Fruit in the top layer warmed up an average of 8.5 degrees during this period while in the bottom layer it changed very little. For the load as a whole there was an average temperature increase of approximately 3 degrees due to the delay in icing.

Results in the second test (table 7) were very similar to those described above. During precooling the fruit in the top layers dropped from an average of 85.5 degrees F. to about 58.0 degrees while in the bottom layer it cooled to about 63.0 degrees. After precooling the car stood on the siding about 17 hours before being iced, the top layer warmed up about 7.5 degrees and the bottom layers changed very little.

Table 8 shows the results obtained with a car to which 4,000 pounds of ice and 100 pounds of salt were added just before precooling with the mechanical unit. Addition of the ice did not increase the rate of cooling as the average hourly reduction was 2.6 degrees, the same as in the two previous tests already discussed (tables 6 and 7). It did, however, greatly decrease the temperature spread between the top and bottom layers. The average fruit temperature in the top layer was only 1.7 degrees lower than that in the bottom layer, whereas in the tests with dry bunkers the spread between top and bottom layers was 5.5 to 7 degrees. Having the ice in the bunkers also materially affected the change in fruit temperature while the car stood on the siding after the completion of precooling. The top layer warmed up an average of only 4 degrees compared with 7 to 8 degrees in cars without ice, and fruit temperatures in the bottom layer continued to drop during the delay in reicing. Average fruit temperatures for the car as a whole decreased about 2 degrees during the 13 hours after precooling.

Iced bunkers without precooling. Due to the lack of precooling facilities, some cars are iced prior to loading and are shipped without precooling. These cars often stand at the packing house or on nearby sidings for almost a full day before moving to market. In order to determine the temperature changes that occur in fruit handled in this manner the test shown in table 9 was conducted. About 6,000 pounds of chunk ice and 200 pounds of salt were added to the bunkers of this car just prior to loading. After loading the car was closed and fruit temperatures were obtained during the 23-hour period it stood on the siding. As the table shows, very little cooling occurred in the top layer, the average temperature of which at completion of loading was about 82.2 degrees. Twenty-three hours later it was 78.8 degrees, a drop of only 3.4 degrees. Fruit in the bottom layer cooled much more rapidly, 21.2 degrees in the 23-hour period. As shown in table 9 outside air temperatures during the period were moderate, remaining below 80 degrees during the entire period of the test. When the car was unloaded in New York on May 13 top layer fruit temperatures had decreased to 58 degrees or 60 degrees and bottom layer fruit temperatures averaged about 50 degrees. This car was reiced at Florence, South Carolina.

Discussion and Summary

From a consideration of the results of the tests described above it appears that oranges, with a pulp temperature of about 90 degrees F. wrapped and packed in standard boxes, and loaded 400 boxes to the car can be cooled by bunker fans, ice, and salt at the rate of 3 to 3.5 degrees per hour during a six to seven hour period. However, since the temperature of the fruit should be reduced to about 50 degrees as soon as possible and maintained at this level or somewhat lower to provide best conditions for its preservation, a longer precooling time should be provided than was given in these tests.

Non-wrapped oranges in Bruce boxes (420 per car) were cooled by means of bunker fans, ice, and salt at rates varying from 0.8 to 2.5 degrees per hour depending on starting temperatures, icing and salting method, and period of operation.

The rate of cooling was greater when part of the salt was added after several hours of operation than when all of the salt was added at the start of precooling.

The rate of cooling was greater when ice of 5 to 15-pound size was used in the bunkers than from ice in 75 to 100-pound chunks.

Oranges in Bruce boxes (420 per car) were cooled by means of truck-mounted, mechanical refrigeration units at the rate of approximately 2.5 degrees per hour during a nine hour period.

The use of two tons of ice and 100 pounds of salt in the bunkers of a car cooled with a mechanical unit did not increase the rate of cooling but did decrease the spread in temperature between top and bottom layers, and prevented a rise in average fruit temperature after the precooling unit was stopped.

When loaded cars were allowed to stand without ice for 14 to 18 hours after the completion of precooling, the average fruit temperature in the top layer rose 7 to 8 degrees. Since the top layer fruit had not been cooled below 55 to 57.7 degrees in the precooling operation this rise in temperature was more serious than it would have been if precooling had been adequate.

A 420- box load of oranges (Bruce boxes) held on track for 23 hours after loading cooled slowly in an iced car when no precooling equipment was used. During this time average fruit temperatures dropped 3.4 degrees in the top layer, and 21.2 degrees in the bottom layer. The average decrease in the whole load was 12.3 degrees in the same period. Even in the bottom layer which had cooled the most the fruit was still 59.1 degrees at time of departure. This is considerably above the level recommended for the most satisfactory transportation of oranges. The relatively warm temperature in the coolest part of this load and warmer temperatures elsewhere in the load show that merely icing the bunkers of a refrigerator car does not take the place of precooling.

Conclusions and Recommendations

Experience has shown that precooling of citrus fruits is necessary at certain times of the year and that the fruit should be precooled to a temperature of 50 degrees F. and maintained at that or a slightly lower temperature during the transit period.

Commodity temperatures averaging 50 degrees or lower throughout the load can be obtained through the use of available precooling equipment if sufficient time is allowed and if the equipment is efficiently operated. Inefficient refrigeration is usually attributable to insufficient refrigerant in the mechanical unit or to failure to keep the ice in the bunkers properly salted and chopped down when bunker fans are used.

To precool heavier loads now required in refrigerator cars, under O. D. T. General Order No. 18, it will be necessary to operate the precooling equipment for a longer time since more heat units must be removed to obtain the desired commodity temperature.

The time required to cool a load depends on the size of the load, the initial fruit temperatures, the rate and volume of air movement, the refrigerating capacity of the cooling medium, and the air temperature outside the car. Since for the most part precooling is done during warm weather, normal variations in outside temperature are not ordinarily a factor of much practical importance in determining the results obtained.

Under comparable conditions the present 525-box load will require about 20 to 25 percent more time to precool than the 420-box load used when this work was done.

The shipper can calculate with fair accuracy the number of hours required to precool a given load of fruit when he knows the fruit temperature at time of loading and the approximate hourly temperature reduction shown in this report for the method he is using.

Table 1. Data Concerning Loading and Precooling of Oranges Season 1941-42
Tests with Bunker Fans - Auburndale, and Jacksonville, Florida.
Tests with Refrigerating Unit Mounted on Truck (Produce Conditioner).

Test No.	Date	Car Initial and Number	Crates		Method of Precooling	Icing Record (Initial)		Precooling				
									Average Commodity Temp.			
			No.	Type		Ice	Salt	Hours	Start	End	Tot. Red.	Hourly Red.
A	10/31/41	FGE 15521	400	Standard	Bunker fans	9600	400	7:25	91.6	65.3	26.3	3.5
B	11/1/41	FGE 15161	400	do	do	9600	400	6:45	86.4	65.6	20.8	3.1 1/
C	5/20/42	FGE 15339	420	Bruce	do	9600	300	7	63.3	57.8	5.5	.8
D	5/20/42	FGE 55403	420	do	do	9600	200 + 200 2/	7	67.5	55.8	11.7	1.7
E	5/21/42	FGE 35522	420	do	do	9600 3/	300	5	75.4	65.7	9.7	1.9
F	5/21/42	FGE 36143	420	do	do	9600 4/	300	5	76.6	66.0	10.6	2.1
G	5/22/42	FGE 33025	420	do	do	9600 3/	300	7	69.7	59.1	10.6	1.5
H	5/22/42	FGE 34700	420	do	do	9600 4/	300	7	75.4	58.1	17.3	2.5
I	5/7/42	BRE 75162	420	do	Produce Cond'r	--	--	9	81.7	58.7	23.0	2.6
J	5/8/42	FGE 19548	404	do	do	--	--	9	84.7	60.9	23.8	2.6
K	5/11/42	FGE 11466	404	do	do	4000	100	9	79.2	55.9	23.3	2.6
L	5/8/42	FGE 14981	420	do	Non-precooled	6000	200		Non-precooled			

1/ Including 40-minutes for switching cars.
2/ 200 lbs. salt added when fans started. Ice barred down three hours later and another 200 lbs. salt added
3/ Chunks 75-100 lbs.
4/ Chunks 5-15 lbs.

Table 2. Precooling with bunker fans, ice, and salt.
Wrapped oranges in standard crates, Auburndale, Florida
Test A: Oct. 31, 1941, FGE 15521 Test B: Nov. 1, 1941, FGE 15161

Hours Pre-cooled		Outside Temperature		Fruit Temperatures															
				Maximum		Minimum		Spread		Average 5 tops		Average 5 bottoms		Avg. 5 tops & 5 bottoms		Average reduction		Hourly Temp. Red.	
A	B1/	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
0	0	83	85	95.5	92.2	87.6	77.1	7.9	15.1	92.3	88.3	90.8	84.4	91.6	86.4	--	--	---	--
1	1	84	86	87.4	85.8	81.7	74.7	5.7	11.1	83.7	79.0	86.0	83.1	84.8	81.1	6.8	5.3	6.8	5.3
2	2	80	86	85.4	83.2	76.6	69.3	8.8	13.9	79.2	73.1	82.7	80.9	80.9	77.0	10.7	9.4	3.9	4.1
3	3	80	87	83.0	81.1	71.5	63.4	11.5	17.7	74.8	67.8	78.8	78.2	76.8	73.0	14.8	13.4	4.1	4.0
4	4	79	87	80.4	79.5	66.1	59.5	14.3	20.0	70.8	64.6	75.2	76.2	73.0	70.4	18.6	16.0	3.8	2.6
5	5	79	87	78.4	77.5	63.2	56.3	15.2	21.2	68.4	61.6	72.9	73.7	70.7	67.6	20.9	18.8	2.3	2.8
6	6	78	86	75.4	75.1	60.5	56.0	14.9	19.1	65.5	62.0	70.0	71.1	67.7	67.0	23.9	19.4	3.0	.6
7	6-2/3	78	86	73.1	74.8	58.8	54.7	14.3	20.1	64.0	60.1	68.1	71.0	66.1	65.6	25.5	20.8	1.6	--
7½	--	78	--	71.7	--	58.3	--	13.4	--	63.2	--	67.3	--	65.3	--	26.3	--	--	--
	6½* hrs. later	--	78	--	65.4	--	53.5	--	11.9	--	62.5	--	56.1	--	59.3	--	27.1	--	--

1/ Including a 40-minute period when fans were stopped for shifting cars, which occurred between the 5th and 6th hrs. of the precooling period.

* Precooling stopped. Awaiting engine.

Table 3. Precooling oranges after loading in refrigerator cars.
Bunker fans, ice, and salt 420 Bruce boxes

Place	Date	Time	Test C - FGE 15339				Test D - FGE 65403			
			75-100 lb. chunks ice, 300 lbs. salt at start				75-100 lb. chunks ice, 200 lbs. salt at start, 200 lbs. salt 4:45 p.m.			
			Air Blast	Avg. Fruit Temp.			Air Blast	Avg. Fruit Temp.		
				Top Layer	Bot'm. layer	All pos.		Top Layer	Bot'm. Layer	All Pos.
Auburndalo, Fla.	5/20/42	1:30p.m.	58.0	65.1	61.0	63.3	--	69.2	65.4	67.5
do	do	2:00p.m.	50.0	63.6	61.5	62.7	51.0	68.4	65.4	67.0
do	do	2:30p.m.	50.0	62.6	62.0	62.3	49.0	65.4	65.4	65.4
do	do	3:30p.m.	49.0	59.9	62.8	61.2	48.5	61.7	65.5	63.4
do	do	4:30p.m.	49.5	57.9	63.2	60.3	48.5	58.7	65.2	61.6
do	do	5:30p.m.	49.5	56.2	63.5	59.4	45.0	55.7	64.4	59.6
do	do	6:30p.m.	50.0	54.8	63.5	58.7	45.5	53.5	63.6	58.0
do	do	7:30p.m.	50.5	54.1	63.8	58.4	47.0	52.1	62.2	56.6
do	do	8:30p.m.	50.5	53.4	63.2	57.8	47.5	51.2	61.5	55.8

Table 4. Precooling oranges after loading in refrigerator cars,
Bunker fans, ice, and salt 420 Bruce boxes.

Place	Date	Time	Test E - FGE 35522				Test F - FGE 36143			
			75-100 lb. chunks ice, 300 lbs. salt -start				5-15 lb. chunks ice, 300 lbs, salt-start			
			Air	Average fruit temp., oF.			Air	Avg. fruit temp, o F.		
			Blast	Top Layer	Bottom layer	All pos.	Blast	Top Layer	Bot layer	All Pos.
Auburndale, Florida	5/21/42	6:00p.m.	60.0	76.4	74.1	75.4	60.0	78.2	74.6	76.6
do	do	6:30p.m.	59.0	75.3	73.9	73.6	49.5	76.6	74.1	75.5
do	do	7:00p.m.	59.0	70.7	73.5	71.9	48.0	74.9	73.5	74.3
do	do	8:00p.m.	59.0	66.5	72.6	69.2	47.5	72.3	72.1	72.2
do	do	9:00p.m.	59.0	63.9	72.5	67.7	46.0	69.2	71.1	70.0
do	do	10:00p.m.	58.5	62.1	71.9	66.4	46.0	66.5	69.6	67.9
do	do	11:00p.m.	58.5	61.0	71.5	65.7	45.5	64.1	68.4	66.0

Table 5. Precooling oranges after loading in refrigerator cars.
Bunker fans, ice, and salt 420 Bruce boxes

Place	Date	Time	Test G - FGE 33025				Test H - FGE 34700			
			75-100lb. chunks ice,400lbs,salt-start				5-15lb. chunks ice,400 lbs. salt-start			
			Air Blast	Avg. fruit temp. oF.			Air Blast	Avg. fruit temp. °F.		
				Top layer	Bot'm Layer	All pos.		Top layer	Bot'm layer	All pos.
Auburndale, Florida	5/22/42	3:10p.m.	54.5	73.3	65.2	69.7	56.0	77.1	73.4	75.4
do	do	3:40p.m.	51.5	71.6	65.8	69.0	52.5	74.1	73.6	73.9
do	do	4:00p.m.	51.0	69.0	65.6	67.5	51.5	70.8	72.9	71.7
do	do	5:00p.m.	50.0	63.9	65.6	64.7	49.5	65.1	72.2	68.3
do	do	6:00p.m.	50.5	60.2	65.8	62.7	48.0	60.4	71.8	65.4
do	do	7:00p.m.	51.5	58.0	65.4	61.3	47.0	56.9	70.4	62.9
do	do	8:00p.m.	51.5	56.7	64.9	60.3	46.5	54.1	69.1	60.8
do	do	9:00p.m.	52.0	55.8	64.2	59.6	45.0	52.1	67.9	59.1
do	do	10:00p.m.	52.0	55.4	63.8	59.1	45.5	50.9	67.0	58.1

Table 6. Precooling oranges after loading in refrigerator car. Truck-mounted mechanical unit.

Place	Date	Time	Outside Temp.	Test I - BRE 75162, bunkers dry			
				Air Blast	Avg. fruit temp.- °F.		
					Top layer	Bot'm,La'r	All pos.
Jacksonville, Florida	5/7/42	1:50 p.m.	87	64.0	81.5	81.8	81.7
do	do	2:20 p.m.	88	50.5	79.6	80.5	80.1
do	do	2:50 p.m.	88	47.0	77.1	78.9	78.1
do	do	4:20 p.m.	89	46.0	71.8	75.4	73.8
do	do	5:20 p.m.	88	42.5	68.6	73.0	71.1
do	do	5:50 p.m.	87	41.5	67.1	71.8	69.7
do	do	7:20 p.m.	83	41.5	62.5	68.4	65.8
do	do	7:50 p.m.	81	39.5	61.0	66.9	64.3
do	do	8:50 p.m.	78	40.5	58.6	65.4	62.4
do	do	9:50 p.m.	77	38.0	57.2	63.8	60.9
do	do	10:50 p.m.	76	34.5	55.0	61.7	58.7
	Precooler off at 10:55 p.m., bunkers dry						
do	5/8/42	7:15 a.m.	67	---	61.1	60.9	61.0
do	do	1:00 p.m.	82	---	63.6	61.6	62.5

Table 7. Precooling oranges after loading in refrigerator cars. Truck-mounted mechanical unit.

Test J - FGE 19548 - Bunkers dry.

Place	Date	Time	Outside Temp.	Air Blast	Avg. fruit temp. - °F.		
					Top Layer	Bottom layer	All pos.
Jacksonville, Fla.	5/8/42	11:20 a.m.	79	50.0	85.5	84.0	84.7
do	do	12:20 p.m.	82	47.0	81.1	80.8	80.9
do	do	12:50 p.m.	82	45.5	78.5	79.0	78.8
do	do	1:50 p.m.	79	45.5	73.1	75.4	74.4
do	do	3:20 p.m.	75	---	71.5	73.5	72.6
do	do	4:20 p.m.	75	---	67.6	70.8	69.4
do	do	6:15 p.m.	71	41.5	64.2	67.7	66.2
do	do	7:20 p.m.	68	34.5	60.4	65.5	63.2
do	do	8:20 p.m.	66	34.0	57.7	63.4	60.9
	Precooler off at 8:20 p.m. - Bunkers dry						
do	5/9/42	7:45 a.m.	58	---	64.3	62.3	63.2
do	do	1:15 p.m.	72	---	65.5	63.3	64.3

Table 8. Precooling oranges after loading in refrigerator car. Truck-mounted mechanical unit.

Test K - FGE 11466 - 4,000 lbs. ice + 100 lbs. salt in bunkers at start.

Place	Date	Time	Outside Temp.	Air Blast	Avg. fruit temp. - °F. Top layer	Bottom layer	All pos.
Jacksonville, Fla.	5/11/42	3:00 p. m.	78	62.0	78.6	79.6	79.2
do	do	3:30 p. m.	79	49.5	77.5	78.6	78.1
do	do	4:00 p. m.	78	46.08	75.6	76.8	76.3
do	do	5:00 p. m.	82	43.0	72.3	73.3	72.8
do	do	6:00 p. m.	81	41.5	69.9	70.0	70.0
do	do	7:00 p. m.	78	41.0	67.5	67.6	67.6
do	do	8:00 p. m.	76	37.5	64.6	64.8	64.7
do	do	9:15 p. m.	74	35.0	61.1	61.7	61.4
do	do	10:00 p. m.	73	36.0	59.5	60.4	60.0
do	do	11:00 p. m.	72	34.5	57.2	58.7	58.1
do	5/12/42	12:05 a. m.	72	35.5	55.1	56.8	55.9
	Precooler off at 12:05 a.m.--1000 lbs. ice in ea. bunker						
do	5/12/42	8:00 a. m.	73	----	57.6	51.2	54.1
do	do	1:00 p. m.	87	----	59.1	49.6	53.8

Table 9. Temperature of oranges in non-precooled car with ice and salt in bunkers.

Test L - FGE 14981 - Iced before loading, 6,000 lbs. ice, 200 lbs. salt

Place	Date Time	Outside Temp.	Air at center of car	Avg. fruit temp. - °F.		
				Top layer	Bottom layer	All Pos.
Jacksonville, Fla.	5/8/42 2:00 p.m.	79	82.0	82.2	80.3	81.2
do	do 4:00 p.m.	74	82.0	82.3	75.6	78.9
do	do 6:00 p.m.	71	82.0	82.2	71.1	76.6
do	5/9/42 7:30 p.m.	58	78.5	79.9	60.5	70.2
do	do 1:00 p.m.	72	77.5	78.8	59.1	68.9